

**WHAT IS CLAIMED IS:**

1. A method for generating a projection of a received signal (y), said signal comprising H, a signal of the source of interest; S, the signals of all other sources and multi-path versions of the source of interest and composed of vectors  $s_1, s_2, s_3, \dots, s_p$ ; and noise (n); the method comprising the steps of:

determining a basis matrix U composed of basis vectors  $u_1, u_2, \dots, u_p$ ;

storing elements of said basis matrix U; and

determining  $y_{\text{perp}}$  where:

$$y_{\text{perp}} = y - U(U^T U)^{-1} U^T y.$$

2. The method recited in claim 1, wherein said step of computing basis vectors comprises the steps of:

A. assigning  $s_1$  as a first basis matrix U;

B. decomposing  $s_2$  into a component which is in said basis matrix U and a component that is not ( $u_2$ ); and

C. redefining the basis matrix U to incorporate basis vector  $u_2$ .

3. The method recited in claim 2, wherein said step of computing basis vectors further comprises the steps of:

repeating steps B and C for each element of S.

4. The method recited in claim 2, wherein said step of computing basis vectors further comprises the steps of:

comparing  $u_i$  to a predetermined threshold and if  $u_i$  is greater than said threshold, adding  $u_i$  to the basis and repeating steps B and C for each element of S, else ignoring the  $u_i$  and continuing to repeat steps B and C.

5. The method recited in claim 2, wherein said step of computing basis vectors further comprises the steps of:

computing  $1/\sigma_i$ , where  $\mathbf{u}_i^T \mathbf{u}_i = \sigma_i$ ; and

storing  $u_i$  and  $1/\sigma_i$

6. The method recited in claim 2, wherein said step of computing basis vectors further comprises the steps of:

computing  $\mathbf{u}_i = \mathbf{s}_i - \mathbf{u}_1 \frac{1}{\sigma_1} \mathbf{u}_1^T \mathbf{s}_i - \mathbf{u}_2 \frac{1}{\sigma_2} \mathbf{u}_2^T \mathbf{s}_i - \dots - \mathbf{u}_{i-1} \frac{1}{\sigma_{i-1}} \mathbf{u}_{i-1}^T \mathbf{s}_i$ ;

storing  $u_i$  and  $1/\sigma_i$ ; and

repeating said computing and storing steps if  $u_i$  is above a predetermined threshold, else ignoring this particular  $u_i$ .

7. The method recited in claim 1, wherein said step of determining  $y_{\text{perp}}$  comprises the step of calculating  $y_{\text{perp}}$  with the following formula:

$$\mathbf{y}_{\text{perp}} = \mathbf{y} - \mathbf{U} \begin{bmatrix} \frac{1}{\sigma_1} & 0 & \dots & 0 \\ 0 & \frac{1}{\sigma_2} & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & \frac{1}{\sigma_p} \end{bmatrix} \mathbf{U}^T \mathbf{y}$$

8. The method recited in claim 1, wherein said step of determining  $y_{\text{perp}}$  comprises the step of calculating  $y_{\text{perp}}$  with the following formula:

$$y_{\text{perp}} = y - u_1 \frac{1}{\sigma_1} u_1^T y - u_2 \frac{1}{\sigma_2} u_2^T y - \dots - u_{p-1} \frac{1}{\sigma_{p-1}} u_{p-1}^T y - u_p \frac{1}{\sigma_p} u_p^T y$$

9. The method recited in claim 1, further comprising the step of determining  $y_s$  where:

$$y_s = U(U^T U)^{-1} U^T y.$$

10. A method for generating a projection from a received signal (y), said signal comprising H, a spread signal matrix of the source of interest; S, the spread signal matrix of all other sources of interest and composed of vectors  $s_1, s_2, s_3, \dots, s_p$ ; and noise (n); the method comprising the steps of:

- A. assigning  $s_1$  as a first basis vector  $u_1$ ;
- B. determining  $\sigma_i$ , where  $u_i^T u_i = \sigma_i$ ; and
- C. storing  $u_i$ ;
- D. computing of inner products of the  $s_{i+1}$  and the  $u_1$  through  $u_i$  vectors;
- E. multiplying said inner product with a respective scalar  $1/\sigma_i$  and thereby creating a first intermediate product
- F. scaling each respective basis vector  $u_i$  by multiplying each respective first intermediate product with each respective basis vector  $u_i$ ;
- G. obtaining a vector sum from step F;
- H. subtracting said vector sum from  $s_{i+1}$  to obtain the next basis vector  $u_{i+1}$ ;
- I. comparing  $u_{i+1}$  to a predetermined value and if equal to or less than said value, discarding the  $u_{i+1}$  and going to step N;

- J. storing  $u_{i+1}$ ;
- K. determining an inner product of  $u_{i+1}^T u_{i+1}$ ;
- L. determining the reciprocal of step K which is  $1/\sigma_{i+1}$ ;
- M. storing  $1/\sigma_{i+1}$ ;
- N. incrementing  $i$ ;
- O. conducting steps D through N until  $i=p$ , where  $p$  is the total number of said sources of interest;
- P. determining  $y_{\text{perp}}$  where:
 
$$y_{\text{perp}} = y - U(U^T U)^{-1} U^T y .$$

11. The method recited in claim 10, wherein said computing step (D) is conducted in series.

12. The method recited in claim 10, wherein said computing step (D) is conducted in parallel.

13. The method recited in claim 10, wherein said multiplying step (E) is conducted in series.

14. The method recited in claim 10, wherein said multiplying step (E) is conducted in parallel.

15. The method recited in claim 10, wherein said scaling step (F) is conducted in series.

16. The method recited in claim 10, wherein said scaling step (F) is conducted in parallel.

17. The method recited in claim 10, wherein said storing step (C) also stores  $\sigma_i$ .

18. The method recited in claim 10, wherein said storing step (C) also stores  $1/\sigma_i$ .

19. The method recited in claim 10, wherein said inner product step (K) is conducted in series.

20. The method recited in claim 10, wherein said inner product step (K) is conducted in parallel.

21. A method for generating a projection from a received signal (y), said signal comprising H, a spread signal matrix of the source of interest; S, the spread signal matrix of all other sources of interest and composed of vectors  $s_1, s_2, s_3, \dots, s_p$ ; and noise (n); the method comprising the steps of:

- A. assigning  $s_1$  as a first basis vector  $u_1$ ;
- B. determining  $\sigma_i$ , where  $u_i^T u_i = \sigma_i$ ; and
- C. storing  $u_i$ ;
- D. computing of inner products of the  $s_{i+1}$  and the  $u_1$  through  $u_i$  vectors;
- E. multiplying said inner product with a respective scalar  $1/\sigma_i$  and thereby creating a first intermediate product;
- F. scaling each respective basis vector  $u_i$  by multiplying each respective first intermediate product with each respective basis vector  $u_i$ ;
- G. serially subtracting said intermediate product from  $s_{i+1}$ ;
- H. utilizing the result from step G and subtracting the next incoming value of  $u_i \frac{1}{\sigma_i} u_i^T s_{i+1}$  until all the values are processed;

- I. obtaining the next basis vector  $u_{i+1}$  from step H;
- J. comparing  $u_{i+1}$  to a predetermined value and if equal to or less than said value, discarding  $u_{i+1}$  and going to step O;
- K. storing  $u_{i+1}$ ;
- L. determining an inner product of  $u_{i+1}^T u_{i+1}$ ,
- M. determining the reciprocal of step K which is  $1/\sigma_{i+1}$ ;
- N. storing  $1/\sigma_{i+1}$ ;
- O. incrementing  $i$ ;
- P. conducting steps D through O until  $i=p$ , where  $p$  is the total number of said sources of interest;
- Q. determining  $y_{\text{perp}}$  where:

$$y_{\text{perp}} = y - U(U^T U)^{-1} U^T y .$$

22. The method recited in claim 21, wherein said computing step (D) is conducted in series.

23. The method recited in claim 21, wherein said computing step (D) is conducted in parallel.

24. The method recited in claim 21, wherein said multiplying step (E) is conducted in series.

25. The method recited in claim 21, wherein said multiplying step (E) is conducted in parallel.

26. The method recited in claim 21, wherein said scaling step (F) is conducted in series.

27. The method recited in claim 21, wherein said scaling step (F) is conducted in parallel.

28. The method recited in claim 21, wherein said storing step (C) also stores  $\sigma_i$ .

29. The method recited in claim 21, wherein said storing step (C) also stores  $1/\sigma_i$ .

30. The method recited in claim 21, wherein said inner product step (L) is conducted in series.

31. The method recited in claim 21, wherein said inner product step (L) is conducted in parallel.

32. An apparatus for generating a projection from a received signal (y), said signal comprising H, a signal of the source of interest; S, the signals of all other sources and composed of vectors  $s_1, s_2, s_3, \dots, s_p$ ; and noise (n); the apparatus comprising:

means for determining a basis vector U;

means for storing elements of said basis vector U; and

means determining  $y_{\text{perp}}$  where:  $y_{\text{perp}} = y - U(U^T U)^{-1} U^T y$ .

33. An apparatus for generating a projection from a received signal (y), said signal comprising H, a spread signal matrix of the source of interest; S, the spread signal matrix of all other sources of interest and composed of vectors  $s_1, s_2, s_3, \dots, s_p$ ; and noise (n); the apparatus comprising:

A. means for assigning  $s_1$  as a first basis vector  $u_1$ ;

B. means for determining  $\sigma_i$ , where  $u_i^T u_i = \sigma_i$ ; and

- C. means for storing  $u_i$ ;
- D. means for computing of inner products of the  $s_{i+1}$  and the  $u_1$  through  $u_i$  vectors;
- E. means for multiplying said inner product with a respective scalar  $1/\sigma_i$  and thereby creating a first intermediate product;
- F. means for scaling each respective basis vector  $u_i$  by multiplying each respective first intermediate product with each respective basis vector  $u_i$ ;
- G. means for obtaining a vector sum from step F;
- H. means for subtracting said vector sum from  $s_{i+1}$  to obtain the next basis vector  $u_{i+1}$ ;
- I. means for comparing  $u_{i+1}$  to a predetermined value and if equal to or less than said value, discarding this  $u_{i+1}$  and going to step N.
- J. means for storing  $u_{i+1}$ ;
- K. means for determining an inner product of  $u_{i+1}^T u_{i+1}$ ;
- L. means for determining the reciprocal of step K which is  $1/\sigma_{i+1}$ ;
- M. means for storing  $1/\sigma_{i+1}$ ;
- N. means for incrementing  $i$ ;
- O. means for conducting steps D through N until  $i=p$ , where  $p$  is the total number of said sources of interest;
- P. means for determining  $y_{\text{perp}}$  where:  $y_{\text{perp}} = y - U(U^T U)^{-1} U^T y$ .

34. An apparatus for generating a projection from a received signal ( $y$ ), said signal comprising  $H$ , a spread signal matrix of the source of interest;  $S$ , the spread signal matrix of all other sources of interest and composed of vectors  $s_1, s_2, s_3, \dots, s_p$ ; and noise ( $n$ ); the apparatus comprising:

- A. means for assigning  $s_1$  as a first basis vector  $u_1$ ;
- B. means for determining  $\sigma_i$ , where  $u_i^T u_i = \sigma_i$ ; and
- C. means for storing  $u_i$ ;



- D. means for computing of inner products of the  $s_{i+1}$  and the  $u_1$  through  $u_i$  vectors;
- E. means for multiplying said inner product with a respective scalar  $1/\sigma_i$  and thereby creating a first intermediate product;
- F. means for scaling each respective basis vector  $u_i$  by multiplying each respective first intermediate product with each respective basis vector  $u_i$ ;
- G. means for serially subtracting said intermediate product from  $s_{i+1}$ ;
- H. means for utilizing the result from step G and subtracting the next incoming value of  $u_i \frac{1}{\sigma_i} u_i^T s_{i+1}$  until all the values are processed;
- I. means for obtaining the next basis vector  $u_{i+1}$  from step H;
- J. means for comparing  $u_{i+1}$  to a predetermined value and if equal to or less than said value, going to step O;
- K. means for storing  $u_{i+1}$ ;
- L. means for determining an inner product of  $u_{i+1}^T u_{i+1}$ ;
- M. means for determining the reciprocal of step K which is  $1/\sigma_{i+1}$ ;
- N. means for storing  $1/\sigma_{i+1}$ ;
- O. means for incrementing  $i$ ;
- P. means for conducting steps D through O until  $i=p$ , where  $p$  is the total number of said sources of interest; and
- Q. means for determining  $y_{\text{perp}}$  where:  $y_{\text{perp}} = y - U(U^T U)^{-1} U^T y$ .

35. A method for generating a projection of a received signal ( $y$ ), said signal comprising  $H$ , a signal of the source of interest;  $S$ , the signals of all other sources and multi-path versions of the source of interest and composed of vectors  $s_1, s_2, s_3, \dots, s_p$ ; and noise ( $n$ ); the method comprising the steps of:

determining a basis matrix  $U$  composed of basis vectors  $u_1, u_2, \dots, u_p$ ;

storing elements of said basis matrix  $U$ ;

determining  $y_{\text{perp}}$  where:

$$\mathbf{y}_{\text{perp}} = \mathbf{y} - \mathbf{U}(\mathbf{U}^T \mathbf{U})^{-1} \mathbf{U}^T \mathbf{y}; \text{ and}$$

determining  $y_s$  where:

$$\mathbf{y}_s = \mathbf{U}(\mathbf{U}^T \mathbf{U})^{-1} \mathbf{U}^T \mathbf{y}.$$

36. The method recited in claim 10, further comprising the step of determining  $y_s$  where:

$$\mathbf{y}_s = \mathbf{U}(\mathbf{U}^T \mathbf{U})^{-1} \mathbf{U}^T \mathbf{y}.$$

37. The method recited in claim 21, further comprising the step of determining  $y_s$  where:

$$\mathbf{y}_s = \mathbf{U}(\mathbf{U}^T \mathbf{U})^{-1} \mathbf{U}^T \mathbf{y}.$$

38. An apparatus for generating a projection from a received signal ( $y$ ), said signal comprising  $H$ , a signal of the source of interest;  $S$ , the signals of all other sources and composed of vectors  $\mathbf{s}_1, \mathbf{s}_2, \mathbf{s}_3, \dots, \mathbf{s}_p$ ; and noise ( $n$ ); the apparatus comprising:

means for determining a basis vector  $\mathbf{U}$ ;

means for storing elements of said basis vector  $\mathbf{U}$ ;

means for determining  $y_{\text{perp}}$  where:  $\mathbf{y}_{\text{perp}} = \mathbf{y} - \mathbf{U}(\mathbf{U}^T \mathbf{U})^{-1} \mathbf{U}^T \mathbf{y}$ .

means for determining  $y_s$  where:

$$\mathbf{y}_s = \mathbf{U}(\mathbf{U}^T \mathbf{U})^{-1} \mathbf{U}^T \mathbf{y}.$$